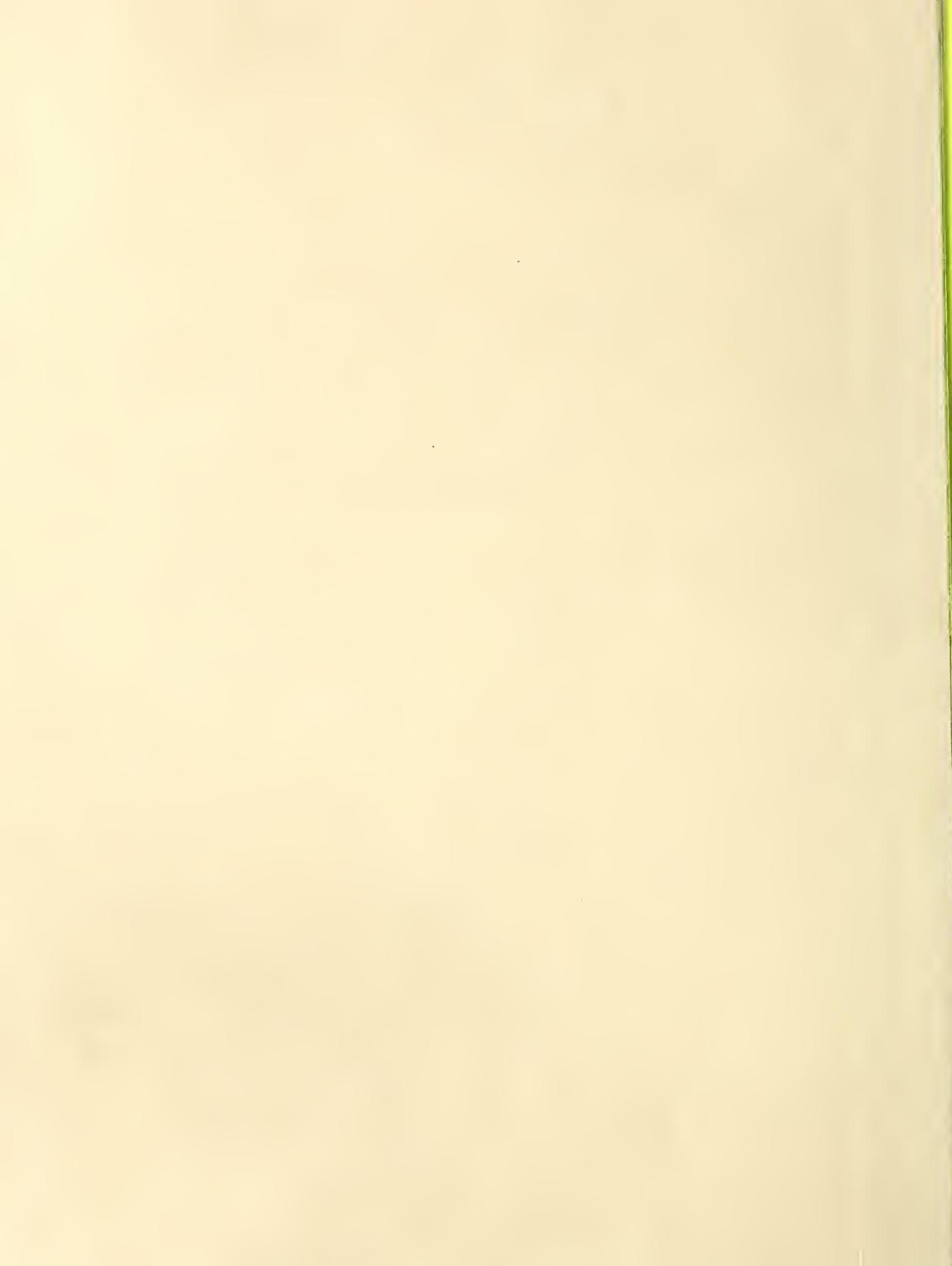
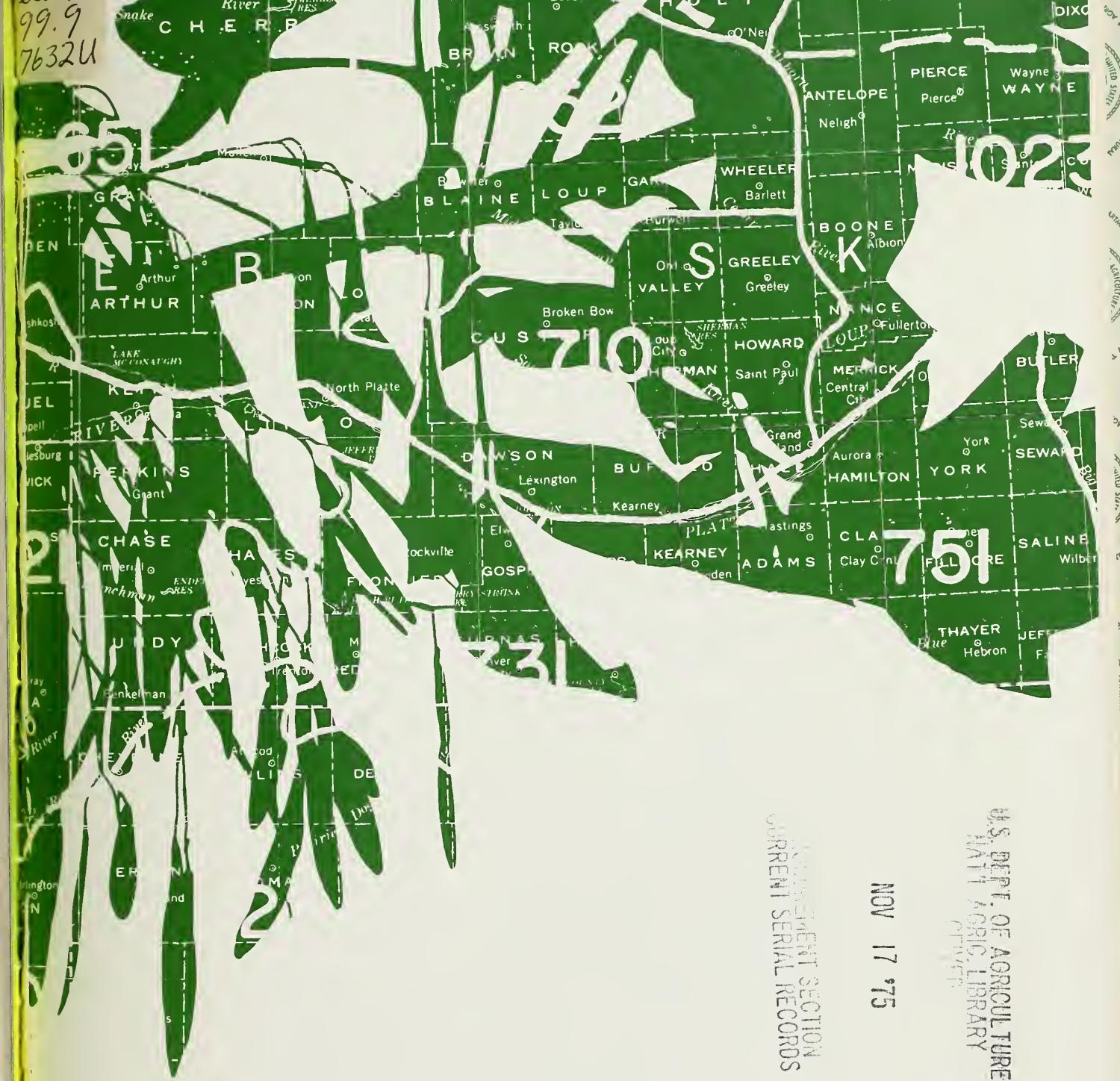


Historic, Archive Document

Do not assume content reflects current scientific knowledge, policies, or practices.





Provisional
Tree and Shrub
Seed Zones
For the Great Plains

Richard A. Cunningham

USDA Forest Service
Research Paper RM-150
Rocky Mountain Forest and
Range Experiment Station
Forest Service
U.S. Department of Agriculture
Fort Collins, Colorado 80521

Great Plains Agricultural Council
Publication No. 71



July 1975

Abstract

Cunningham, Richard A.

1975. Provisional tree and shrub seed zones for the Great Plains. USDA For. Serv. Res. Pap. RM-150, 15 p. Rocky Mt. For. and Range Exp. Stn., Fort Collins, Colo. 80521

The Great Plains Region was subdivided into 86 seed collection zones on the basis of soil, topography, water, and climate. Seed should be collected from the zone to be planted, or, if unavailable, from a zone having similar soil and climate. Future provenance test results will be used to determine any need for adjustments in zone boundaries.

Keywords: Seed zones, Great Plains, forest seed planting.

USDA Forest Service
Research Paper RM-150

July 1975

200^o

Provisional Tree and Shrub Seed Zones for the Great Plains

Richard A. Cunningham¹

Great Plains Agricultural Council
Publication No. 71

¹Cunningham is a Forest Geneticist, now with the Rocky Mountain Region of the U.S. Forest Service, Denver, Colorado. He was formerly with the Rocky Mountain Forest and Range Experiment Station's Shelterbelt Laboratory at Bottineau, in cooperation with North Dakota State University - Bottineau Branch and Institute of Forestry. The Station maintains central headquarters in Fort Collins in cooperation with Colorado State University.

Preface

This publication is sponsored by the Great Plains Agricultural Council. The Council is composed of Directors of the Agricultural Experiment Stations and Cooperative Extension Services of Colorado, Kansas, Montana, Nebraska, New Mexico, North Dakota, Oklahoma, South Dakota, Texas, and Wyoming, and representatives of 11 agencies of the U.S. Department of Agriculture directly concerned with advancement of agriculture in these States.

This system of seed zoning was developed as one of the initial activities of Technical Committee GP-13, a regional tree improvement project sponsored by the Research Committee of the Great Plains Agricultural Council. The committee consists of 29 members from various State and Federal agencies in the 10 Plains States.

The development of tree seed zoning for the Great Plains was heavily dependent upon the many helpful suggestions of several GP-13 members, and their assistance is gratefully acknowledged.

Publication of this paper was a joint effort of the Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado, and The Rocky Mountain Region, Denver, Colorado. Copies may be obtained from either of these units of the Forest Service, U.S. Department of Agriculture.

KARL WENGER, Adm. Advisor (now retired),
GP-13 Regional Tree Improvement
Technical Committee

**GP-13 REGIONAL TREE IMPROVEMENT
TECHNICAL COMMITTEE
MEMBERSHIP LIST-JULY 1975**

COLORADO

Mr. David E. Herrick
GP-13 Administrative Advisor
Rocky Mountain Forest and Range
Experiment Station, USDA-FS

240 West Prospect
Fort Collins, Colorado 80521

Dr. Gilbert H. Fechner
Colorado Experiment Station
Forest and Wood Sciences Department
Colorado State University
Fort Collins, Colorado 80523

Mr. Sidney H. Hanks
(represented by Dr. Richard A. Cunningham)
Forest Service, USDA
Rocky Mountain Region
11177 W. 8th Ave., P. O. Box 25127
Lakewood, Colorado 80215

Mr. Marvin D. Strachan
Colorado State Forest Service
Foothills Campus
Colorado State University
Fort Collins, Colorado 80523

KANSAS

Dr. Fred Deneke
Department of Horticulture and Forestry
Waters Hall, Kansas State University
Manhattan, Kansas 66506

Mr. Jerry Dickerson
Agric. Research Service, USDA
Wind Erosion Laboratory
Kansas State University
Manhattan, Kansas 66506

Mr. Gary G. Naughton
State and Extension Forestry
2610 Claflin Road
Manhattan, Kansas 66502

MONTANA

Mr. Willis Heron
Montana Department of Natural
Resources and Conservation
2705 Spurgin Road
Missoula, Montana 59801

Dr. George Howe
Forest Service, USDA
Northern Region
Federal Building
Missoula, Montana 59801

Dr. Orville McCarver
Agricultural Experiment Station
Montana State University
Bozeman, Montana 59715

NEBRASKA

Mr. Walter Bagley
Department of Forestry
107 Plant Industry Building
University of Nebraska
Lincoln, Nebraska 68503

Mr. William Lovett
Department of Forestry
Miller Hall
University of Nebraska
Lincoln, Nebraska 68503

Dr. Glenn W. Peterson
Rocky Mountain Forest and Range
Experiment Station, USDA-FS
Forestry Sciences Lab, East Campus
University of Nebraska
Lincoln, Nebraska 68503

Mr. Ralph A. Read
Rocky Mountain Forest and Range
Experiment Station, USDA-FS
Forestry Sciences Lab, East Campus
University of Nebraska
Lincoln, Nebraska 68503

Dr. Jerry Riffle
Rocky Mountain Forest and Range
Experiment Station, USDA-FS
Forestry Sciences Lab, East Campus
University of Nebraska
Lincoln, Nebraska 68503

Mr. Ashley A. Thornburg
Midwest Regional Technical Service Center
Soil Conservation Service-USDA
134 S. 12th Street, Room 503
Lincoln, Nebraska 68508

Dr. David F. Van Haverbeke
Rocky Mountain Forest and Range
Experiment Station, USDA-FS
Forestry Sciences Lab, East Campus
University of Nebraska
Lincoln, Nebraska 68503

NEW MEXICO

Dr. Jack Pitcher
Forest Service, USDA
Southwestern Region
517 Gold Avenue, S.W.
Albuquerque, New Mexico 87101

NORTH DAKOTA

Dr. Albert B. Frank
Agric. Research Service, USDA
Northern Great Plains Res. Ctr.
P. O. Box 459
Mandan, North Dakota 58554

Mr. Richard Gilmore
Staff and Nurseries Forester
North Dakota Forest Service
Bottineau, North Dakota 58318

Mr. Robert Heintz
Department of Horticulture
North Dakota State University
Fargo, North Dakota 58102

Mr. James L. Van Deusen
Rocky Mountain Forest and Range
Experiment Station, USDA-FS
Shelterbelt Laboratory
P. O. Box 25
Bottineau, North Dakota 58318

OKLAHOMA

Dr. Clark W. Lantz
Oklahoma Experiment Station
Department of Forestry
Oklahoma State University
Stillwater, Oklahoma 74074

SOUTH DAKOTA

Dr. Paul E. Collins
Horticulture and Forestry Department
South Dakota State University
Brookings, South Dakota 57006

Mr. James Suedkamp
Division of Forestry
Big Sioux Conifer Nursery
Route 2
Watertown, South Dakota 57201

TEXAS

Mr. Robert Fewin
Texas Forest Service
Agronomy Department
Texas Tech University
Lubbock, Texas 77866

Dr. William J. Lowe
Forest Science Laboratory
Texas A & M University
College Station, Texas 77843

WASHINGTON, D.C.

Dr. Boyd W. Post
Cooperative States Research Service
U.S. Department of Agriculture
South Building
Washington, D.C. 20250

WYOMING

Dr. Charles McAnelly
Plant Science Division
Wyoming Experiment Station
University of Wyoming
Laramie, Wyoming 82070

Contents

	<i>page</i>
Preface	i
Introduction	1
Why Seed Collection Zones are Necessary	1
Criteria Used in Delineating Seed Zones	1
Numbering System for Seed Zones	3
Land Resource Regions	3
D. Southern Desertic Basins, Plains, and Mountains	Zones 421-422
F. Northern Great Plains	Zones 521-562
G. Western Great Plains	Zones 581-700
H. Central Great Plains	Zones 710-803
I. Southwestern Plateaus and Plains	Zones 811-833
J. Southwestern Prairies	Zones 841-871
M. Central Prairies and Loess Drift Hills	Zones 1021-1122
N. Ouachita Mountains	Zone 1191
P. Gulf Rolling Plain	Zones 1331-1332
T. Gulf Coast Prairies	Zones 1501-1502
Putting the Seed Collection Zones to Use	5
Literature Cited	5
Seed Zone Maps	6-13
Appendix - Approximate Equivalents of Great Soils Groups	14-15

Provisional Tree and Shrub Seed Zones for the Great Plains

Introduction

Seed collection zones are subdivisions of land areas established to identify seed sources and to control the movement of seed and planting stock. Seed zones are needed for many species because of the genetic variation associated with their geographic distribution. Zone boundaries may be delineated from experimental data that identify genetic variation, or by analysis of the environmental factors that most likely acted as selective forces in creating such genotypic variation.

Why Seed Collection Zones are Necessary

Geographic variation within several tree and shrub species native to the Great Plains is well documented.

Significant variation in drought tolerance, height growth, and winter injury has been reported for *Fraxinus pennsylvanica* Marsh. by several investigators (Bagley 1970, Collins 1971, Meuli and Shirley 1937). In a provenance test of *Populus deltoides* Bartr. from 25 origins in the southern Great Plains, Posey (1969) detected significant variation among origins in growth rate, fiber length, and drought resistance. Conley et al. (1965) reported geographic variation among *Pinus ponderosa* Laws. seed sources from the northern Great Plains. After nearly 20 years' growth in north-central North Dakota, 10 origins varied considerably in survival, height and diameter growth, branching habit, and foliage density.

In a taxonomic study of *Juniperus* species in the Missouri River Basin, Van Haverbeke (1968) reported considerable intraspecies variation in a number of morphological traits for both *J. scopulorum* Sarg. and *J. virginiana* L., as well as evidence that the two species were hybridizing where their ranges overlapped.

Trees or shrubs grown from local seed are usually best adapted to conditions in that locality (Rudolf 1957). Although introduced races may sometimes be superior to local races, it is best to rely upon a local seed source whenever possible, unless a nonlocal seed source has proved superior in a comparative planting (provenance test).

In an area such as the Great Plains, where natural populations of trees are usually in small, widely scattered groves, it is often necessary to plant nonlocal races, since there are no local races available. For this reason, it is important to know

whether the seed for a particular planting originated under conditions comparable to those of the planting site. One way to evaluate seed sources is to establish homogeneous seed collection zones, and identify each lot of seed used to produce planting stock by zone of origin. This procedure will also provide a means for checking field performance in relation to seed origin.

Criteria Used in Delineating Seed Zones

Since information on racial variation among tree and shrub species growing in the Great Plains is quite limited, a seed zoning system must be based primarily on criteria that are only speculative at this stage. After the system has been in use for a number of years, sufficient data should be available from outplantings to permit a reevaluation of the criteria used and the accuracy of the seed zone boundaries.

The USDA Forest Service made the first attempt at tree and shrub seed zoning in the Great Plains in its Prairie States Forestry Project (Engstrom and Stoeckeler 1941). Eleven zones were established in the entire Great Plains, based primarily on latitude. While this system was a step in the right direction, it has not been widely accepted or utilized by seed dealers or nurserymen in the Great Plains. Thus we must look to regions other than the Great Plains for examples of effective seed zoning.

California is divided into six physiographic and climatic regions, 32 subregions, and 85 seed collection zones (Buck et al. 1970). Criteria used in delineating the seed zone boundaries were latitude, elevation, and unusual climatic, topographic, or edaphic conditions that might affect tree growth.

In the Lake States, where topography is less important, Rudolf (1957) developed a series of zones on two temperature factors: (1) summation of normal average daily temperatures per year above 50° F, and (2) mean January temperature. He delineated 10 primary zones for Minnesota, and 8 each for Michigan and Wisconsin.

The forested areas of Arizona and New Mexico were divided into 10 physiographic-climatic regions; each were then subdivided into five to nine seed collection zones about 50 miles wide (Schubert and Pitcher 1973).

Seed collection zones in Ontario, Canada, are based on the site regions developed by Hills (1960). This system divides the Province into 12 regions based primarily on temperature and moisture; the regions are then subdivided into physiographic (landform) groupings differing in moisture, eco-climate, and nutrients (Holst 1962).

In the Pacific Northwest, the Western Forest Tree Seed Council published maps in 1966 showing seed collection zones based on geographic zones and 500-foot elevation bands.²

These examples illustrate that a wide array of factors may be used in delineating seed collection zones. As part of an effort to determine the most reliable combination of environmental variables for delineating seed zones in the Great Plains, we

surveyed nurserymen, tree planters, foresters, soil scientists, and geneticists working in the Plains. The criteria they most often suggested as being important for tree and shrub survival and growth were: adaptability to droughty sites, cold hardiness, and tolerance to adverse soil conditions. Primary climate and site factors that determine these criteria were chosen to form the base for the seed zoning system.

The soils of the Great Plains are described in detail in "Land Resource Regions and Major Land Resource Areas of the United States" (Austin 1972). Austin's map (fig. 1) delineating the major land resource regions and areas in the Great Plains was

²Map, as revised 1973, is available from West. For. and Conserv. Assoc., Am. Bank Build., Portland, Oreg.

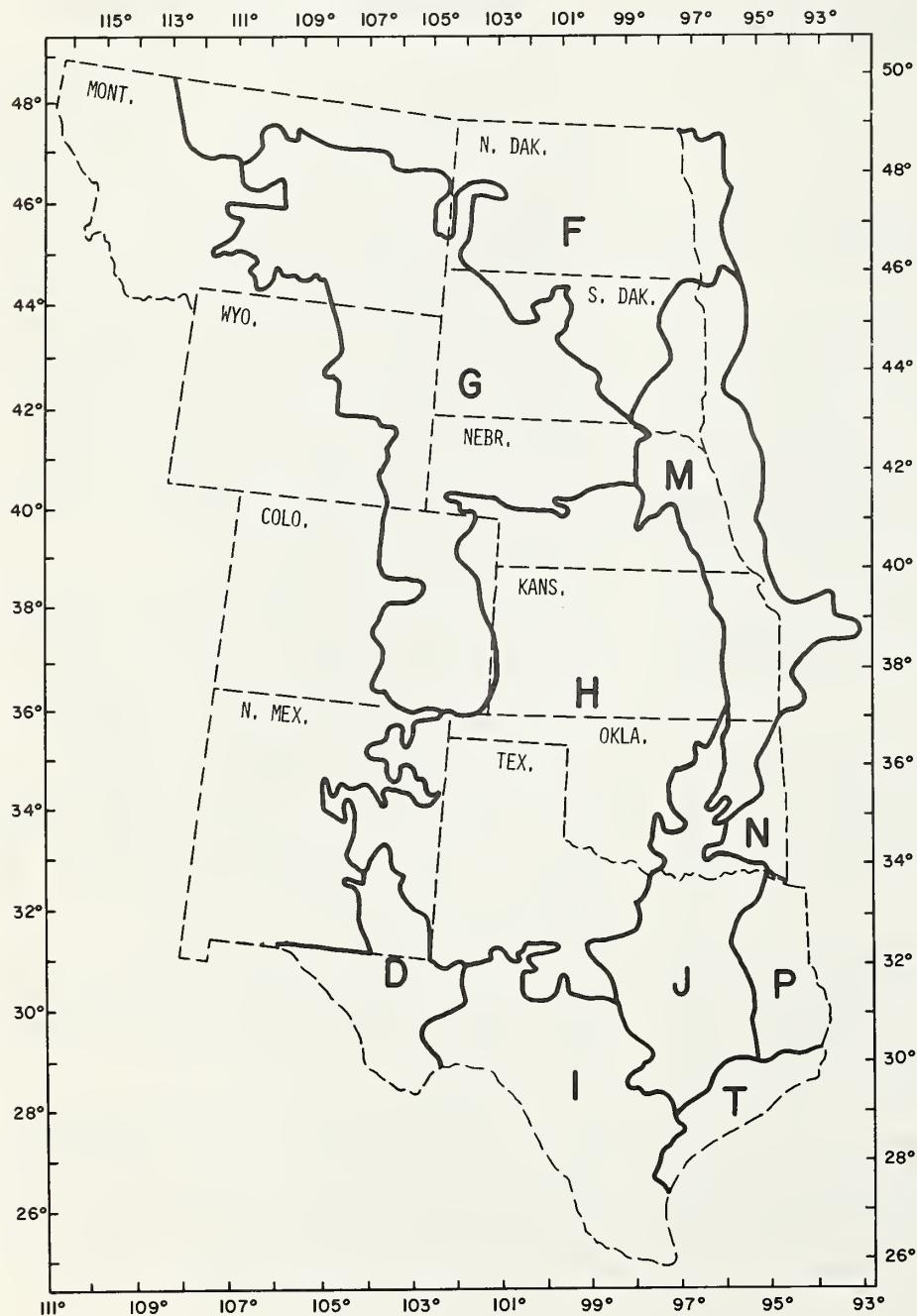


Figure 1.—
Major land
resource regions
of the
Great Plains
(adapted from
Austin 1972).

used as the base map for designating seed zones. Climatic data were taken from the "Climatic Atlas of the United States" (U.S. Department of Commerce 1968). The provisional seed zones were the result of superimposing the climatic data over the map of the major land resource areas (figs. 2, 3, 4).

Minimum winter temperatures were assumed to be the best measure of cold hardiness. Isopleths of mean January temperatures at 5-degree intervals were superimposed over the map of major land resource areas. This combination provided a good latitudinal division of many of the larger areas.

Isopleths of normal annual precipitation (4-inch intervals) were also superimposed over the land resource map. In most instances, longitudinal boundaries of the major land resource areas corresponded closely with isopleths of annual precipitation. The isopleths of annual precipitation were therefore used to subdivide the area only in instances where a seed zone would be larger than the 4-inch interval.

Boundaries of the seed zones were altered in some cases to make them conform to recognizable land features such as rivers, lakes, and highways. In several instances, several small major land resource areas were combined into one seed zone where differences among them were judged minor in their effect on tree growth and survival.

The proposed seed zones encompass an area somewhat larger than that normally considered the Great Plains, to provide at least a provisional system in those States with areas both within and adjacent to the Great Plains.

Numbering System for Seed Zones

The three- or four-digit designation (WXYZ) used in numbering the seed collection zones is a modification of the Soil Conservation Service's numbering system for the major land resource areas (Austin 1972). The major land resource areas are designated by two- or three-digit numbers in the XY and WXY positions. Division of the major land resource areas, which we designate as seed collection zones, are indicated by the digit in the Z position. Examples of this designation are:

Zone 552.—The 55 represents major land resource area 55 in the Northern Great Plains region. There is no thousand-digit in the W position. The 2 indicates seed collection zone 2 of land resource area 55.

Zone 1073.—Seed collection zone 3 in land resource area 107.

Land Resource Regions

The 10 land resource regions upon which this system of seed zoning is based (Austin 1972) are

shown in figure 1. Regions D, M, P, and T are only partially within the area being considered, and therefore any references to these regions relate to individual land resource areas rather than the region as a whole. A brief description of each region follows.

D. Southern Desertic Basins, Plains, and Mountains (Seed Zones 421-422)

Broad desert basins and valleys range from 2,500 to 5,000 feet in elevation. Red Desert soils and Lithosols³ are the dominant soils of the area. Annual precipitation averages 12 to 16 inches. Mean January temperatures range from 40° F in the north to 45° F in the south.

F. Northern Great Plains (Seed Zones 521-562)

Fertile soils and smooth topography characterize this region. Chernozems and Chestnut soils cover the western part. Other important soils are Lithosols on steep slopes, Solentz and Humic Gley soils on terraces and in depressions, and narrow bands of alluvial soils along major streams. Elevation varies from 1,000 feet in the east to 4,000 feet in the west.

Annual precipitation ranges from 10 to 24 inches; much of it falls during the growing season. Mean January temperature varies from 0° F in the north to 20° F in the south.

G. Western Great Plains (Seed Zones 581-700)

Unfavorable soils, strong slopes, or low moisture supplies make tree or shrub survival uncertain on all but the most favorable sites in this region. The topography rises from 2,000 feet elevation in the east to 6,000 feet in the west. Annual precipitation ranges from 11 to 24 inches, but fluctuates widely from year to year. Mean January temperatures vary from 10° F in the north to 40° F in the south.

³For approximate equivalents of great soil groups, see appendix (table taken from Austin 1972, p. 81-82). In October 1973, the Soil Survey Staff prepared an interim publication for inservice use, "Preliminary abridged text—Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys," 330 p. USDA Soil Conserv. Serv., Wash., D.C.

H. Central Great Plains (Seed Zones 710-803)

Soils, topography, and climate are more favorable for tree growth in this region than in the Great Plains to the north and west. Elevation increases from 1,000 feet in the east to 5,000 feet in the southwest.

The important soils in the north are in the Chernozem and Chestnut groups. Reddish Prairie and Reddish Chestnut soils are extensive in the south. Lithosols on steep slopes, Regosols in deep sands, and alluvial soils on flood plains are common throughout the area.

Average annual precipitation is 20 to 30 inches over much of the region, but ranges from 15 to 35 inches. Precipitation increases from northwest to southwest. More rain falls in summer than in the rest of the year. Mean January temperatures range from 25° F to 45° F, and increase from north to south.

I. Southwestern Plateaus and Plains (Seed Zones 811-833)

This region consists of the warmer part of the southern Great Plains. The moderate precipitation is accompanied by high temperatures so that precipitation effectiveness is low. Average annual precipitation is 20 to 30 inches over most of the region, but ranges from 15 to 35 inches; usually much of it falls in spring and autumn. Mean January temperatures range from 45° F to over 60° F.

Soils in the deeper coarse- and medium-textured materials are mostly in the Reddish Chestnut and Reddish Prairie great soil groups. Grumusols from limestones and marls and Lithosols and Calcisols in all kinds of parent material on hilly to steep slopes are also fairly extensive.

J. Southwestern Prairies (Seed Zones 841-871)

This region consists of the prairies and timbered areas of eastern Texas and south-central Oklahoma. Average annual precipitation ranges from 25 to 42 inches. Mean January temperature is 35° F to 55° F.

Grumusols, Rendzinas, and Lithosols from limestone and chalks are the more extensive soils. Red-Yellow Podzolic soils, Planosols, and Reddish Prairie soils are also important groups.

M. Central Prairies and Loess Drift Hills (Seed Zones 1021-1122)

Fertile soils and favorable climate make this region more suitable for tree survival and growth than almost any other region in the Great Plains. Annual

precipitation is 25 to 35 inches over much of the region, but ranges from 20 inches in the extreme north to 45 inches in the south. Mean January temperature varies from 10° F in the north to 40° F in the south.

Chernozems are dominant in the north, while Brunizems are the major soils in the central area. Planosols are prevalent in the south. Alluvial and Humic Gley soils are common on flood plains.

N. Ouachita Mountains (Seed Zone 1191)

This region is characterized by steep mountains and narrow stream valleys with steep gradients. Elevation varies from 300 feet on the lowest valley floors to 2,700 feet on the highest mountain peaks. Lithosols and rough stony land occupy most of the steep slopes throughout the area. Red-Yellow Podzolic soils are on the gentle slopes of ridgetops, benches, foot slopes, and old stream terraces.

Annual precipitation averages 44 to 56 inches. Mean January temperatures vary from 42° F to 45° F.

P. Gulf Rolling Plain (Seed Zones 1331-1332)

This region of gently sloping to rolling plains varies in elevation from 100 to 300 feet, with small areas approaching 500 feet. Red-Yellow Podzolic soils are dominant throughout the region.

Annual precipitation averages 46 to 56 inches, with most of it falling in winter and spring. Mean January temperature varies from 45° F in the north to 55° F in the south.

T. Gulf Coast Prairies (Seed Zones 1501-1502)

This region consists of the nearly level low parts of the Gulf Coastal Plains. Elevation ranges from sea level to about 200 feet along the interior margin. Grumusols, Planosols, and Low-Humic Gley soils, all from calcareous clays and marls, are the dominant soils.

Annual precipitation averages from 26 inches in the west to 56 inches in the east. Mean January temperature varies from 55° F to 60° F.

Putting the Seed Collection Zones to Use

To be effective, the zones should be used by all agencies collecting and using tree and shrub seeds

within the Great Plains region. Use of the zones not only will provide valuable information about the origin of the seed used to produce planting stock, but will also enable the consumer to select planting stock with adequate survival and growth potential.

Tree and shrub species not native to the Great Plains have been planted extensively in the region for many years. Many of these plantings are now bearing seed and, though often of unknown origin, are the only local source of seed available for these species. Seed collected from these plantings of untested exotics should be used with caution, since these populations have not been subjected to the long-term selection pressures of cold, drought, insects, and diseases that have resulted in locally adapted races of native species.

Plantings of exotic species that have attained at least three-fourths of their life expectancy and appear healthy and are growing vigorously may be used as seed sources with reasonable assurance they will produce planting stock adequately adapted to the seed zone in which the parent trees are growing.

This scheme for seed zoning is designed to make the process of identifying seed sources easier for the nurseryman. When seed is collected it should be labeled accurately as to origin, in as much detail as possible. Often this means specifying section, township, and range. In several States this information is mandatory under seed labeling laws. When the seed is planted by nurserymen, however, only the seed collection zone number need be used in identifying a particular lot of seedlings. Thus several different seed sources might be grown together in one lot of seedling stock, which would be designated as having been grown from seed of a particular seed collection zone. This procedure should vastly reduce the number of seed lots that must be kept separate in the nursery, but would still provide valuable information about the seed source.

This seed collection zoning system is provisional at this time. When sufficient information on racial variation within several tree and shrub species growing in the Great Plains is available, the system will be revised as necessary to reflect any changes suggested by analysis of such data.

Literature Cited

Austin, Morris E.

1972. Land resource regions and major land resource areas of the United States. U.S. Dep. Agric., Agric. Handb. 296, 82 p.

Bagley, Walter T.

1970. Tree improvement in Nebraska, a progress report. 22d Annu. Meet., For. Comm., Great Plains Agric. Counc. [Minot, N.D., June 1970]. Proc. 7 p.

Buck, J. M., R. S. Adams, J. Cone, and others.

1970. California tree seed zones. U.S. Dep. Agric., For. Serv., Calif. Reg. and Calif. Resourc. Agency, Dep. Conserv., Div. For. Mimeo., 5 p.

Collins, Paul E.

1971. Importance of tree seed sources. S. Dak. Farm Home Res. 22(3):6-8.

Conley, W. T., D. H. Dawson, and R. B. Hill.

1965. The performance of eight seed sources of ponderosa pine in the Denbigh Experimental Forest, North Dakota. U.S. For. Serv. Res. Note LS-71, 4 p. Lake States [North Central] For. Exp. Stn., St. Paul, Minn.

Engstrom, Harold E., and J. H. Stoeckeler.

1941. Nursery practice for trees and shrubs suitable for planting on the Prairie Plains. U.S. Dep. Agric., Misc. Publ. 434, 159 p.

Hills, G. A.

1960. Regional site research. For. Chron. 26:401-423.

Holst, M.

1962. Seed collection and tree breeding in Canada. Can. Dep. For., Res. Br., Tech. Note 115, 20 p.

Meuli, L. J., and H. L. Shirley.

1937. The effect of seed origin on drought resistance of green ash in the Prairie Plains States. J. For. 35:1060-1062.

Posey, C. E.

1969. Phenotypic and genotypic variation in eastern cottonwood in the southern Great Plains. Proc. 10th South. Conf. For. Tree Improve., [Houston, Tex.], p. 130-135.

Rudolf, P. O.

1957. Lake States tree seed collection zones. 14 p. Mich. Dep. Conserv., For. Div., Lansing.

Schubert, Gilbert H., and John A. Pitcher.

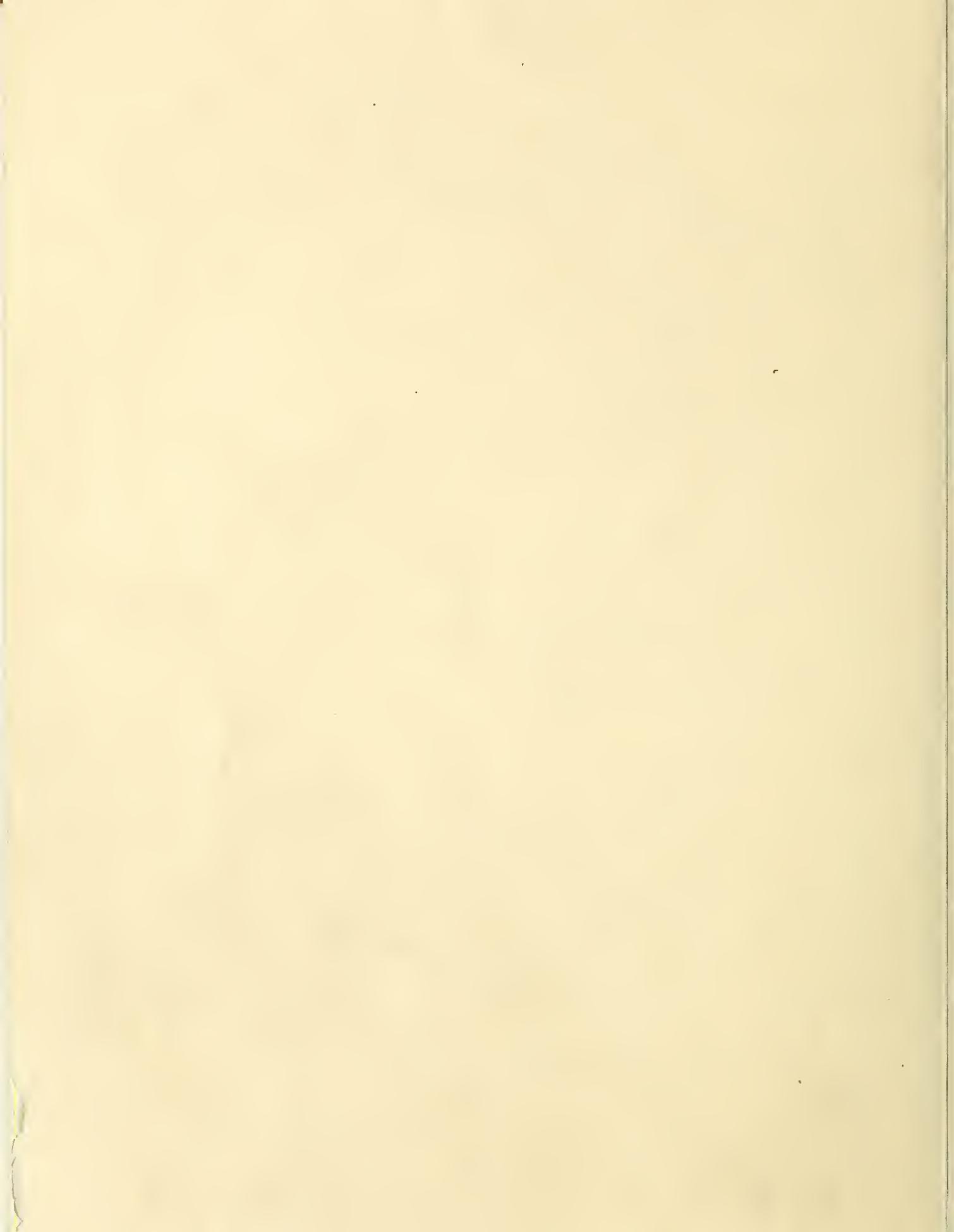
1973. A provisional tree seed-zone and cone-crop rating system for Arizona and New Mexico. USDA For. Serv. Res. Pap. RM-105, 8 p. Rocky Mt. For. Range Exp. Stn., Fort Collins, Colo.

U.S. Department of Commerce.

1968. Climatic atlas of the United States. 80 p. Environ. Data Serv., U.S. Dep. Comm., Wash. D.C.

Van Haverbeke, David F.

1968. A taxonomic analysis of *Juniperus* in the central and northern Great Plains. Proc. 6th Cent. States For. Tree Improv. Conf. [Carbon-dale, Ill., Oct. 1968], p. 48-52.



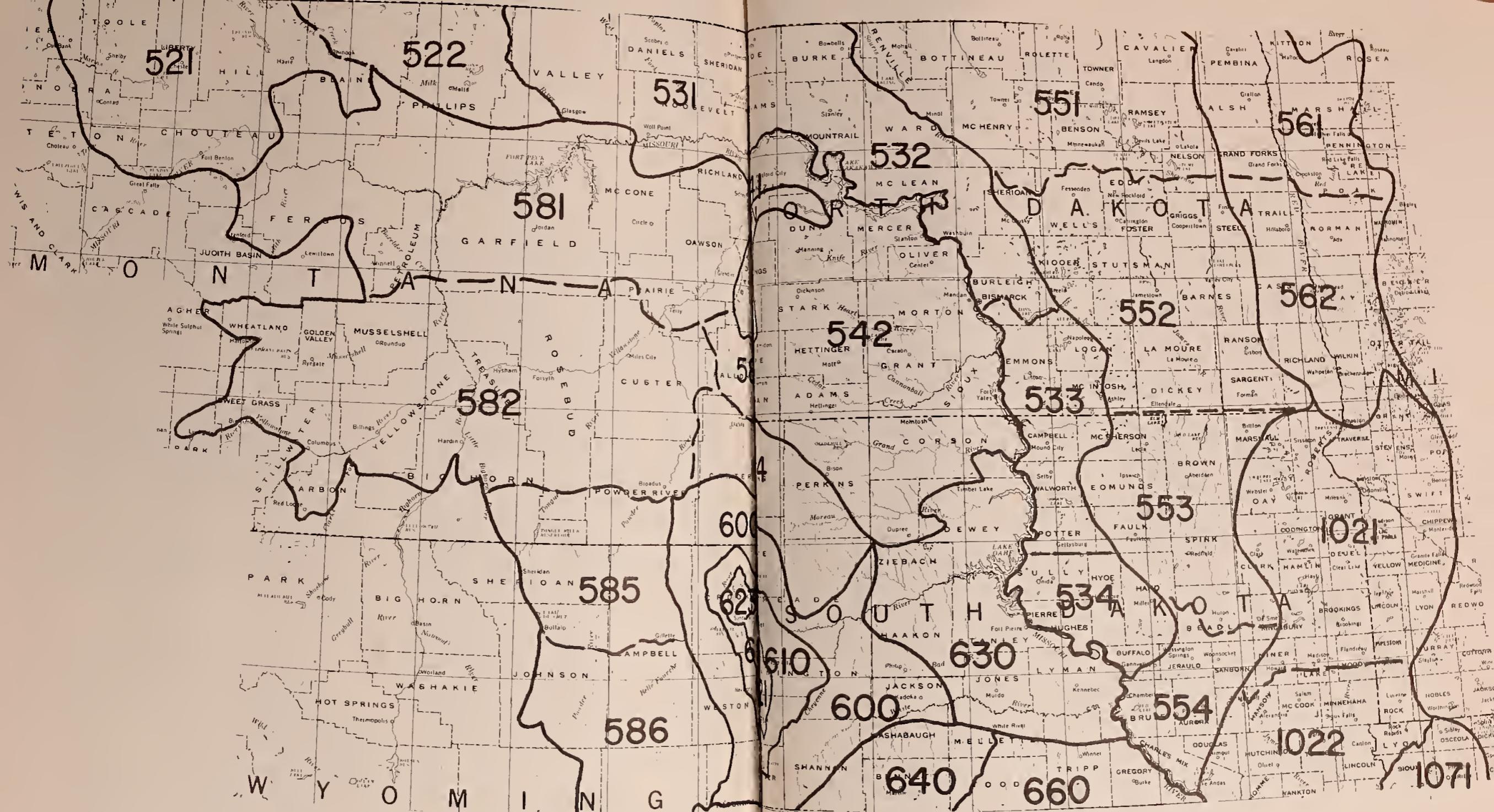


Figure 2.—Provisional seed zones for the Northern Great Plains.



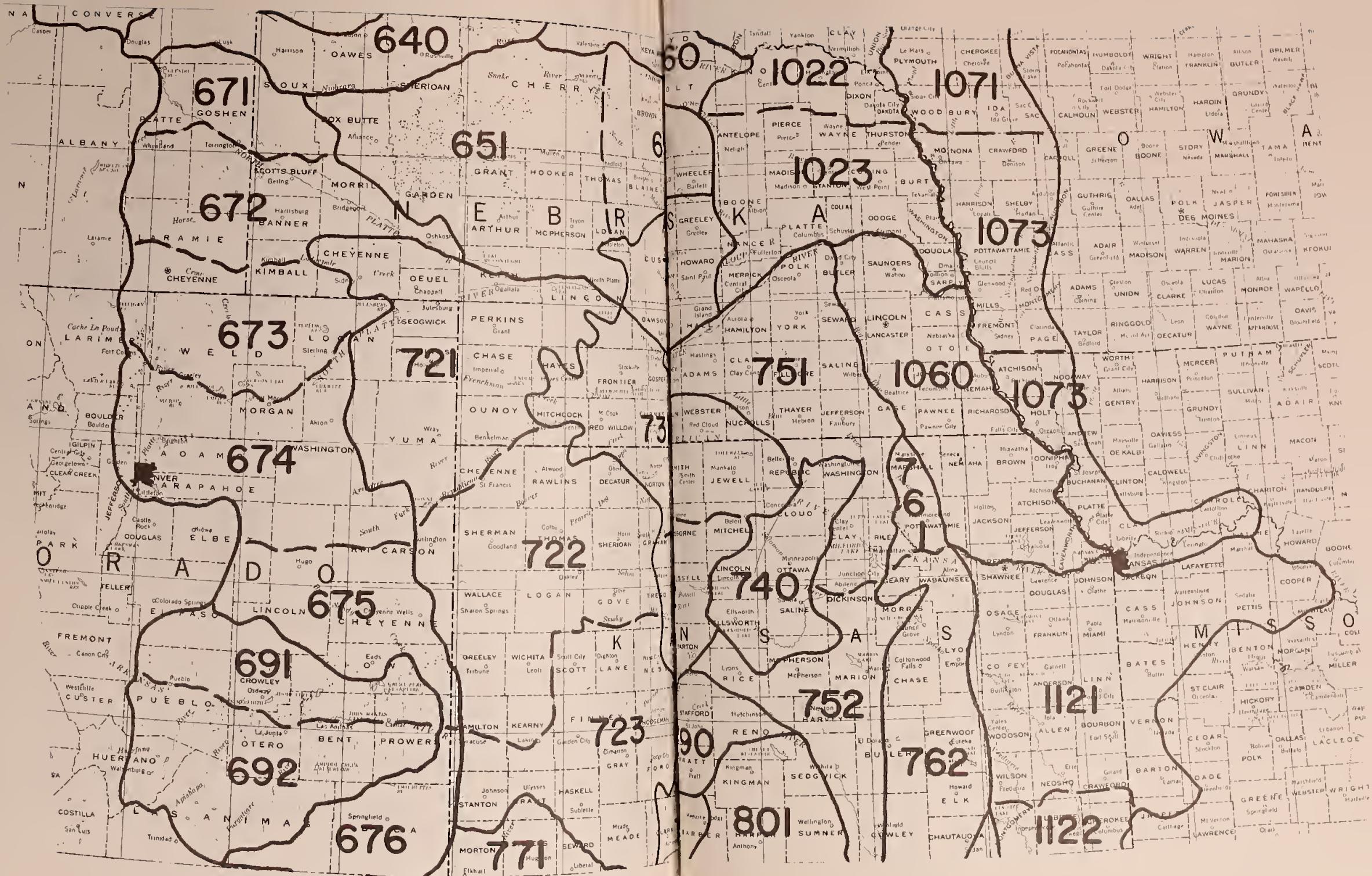


Figure 3.—Provisional seed zones for the Central Great Plains.



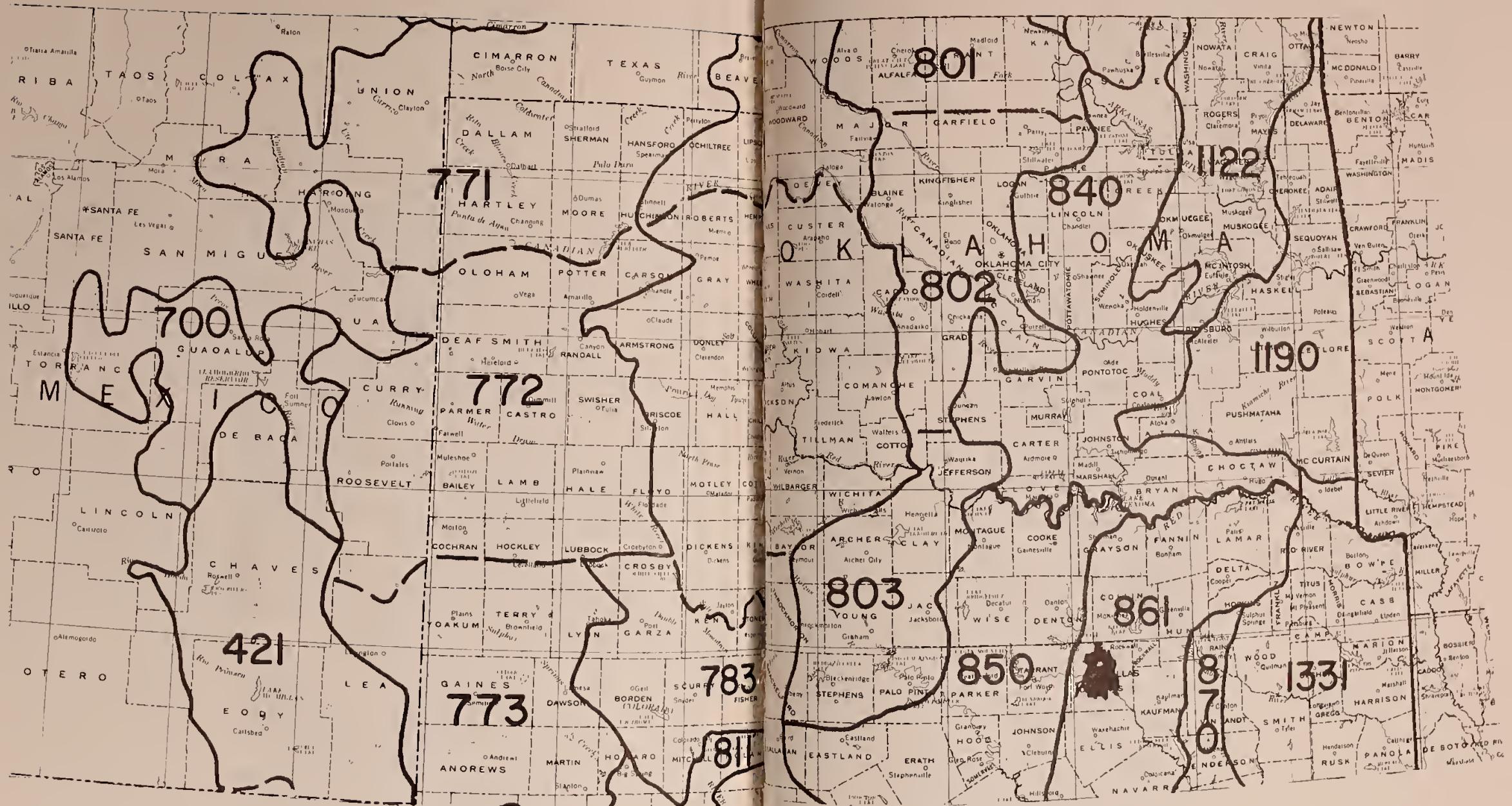


Figure 4.—Provisional seed zones for the Southern Great Plains (map 1).



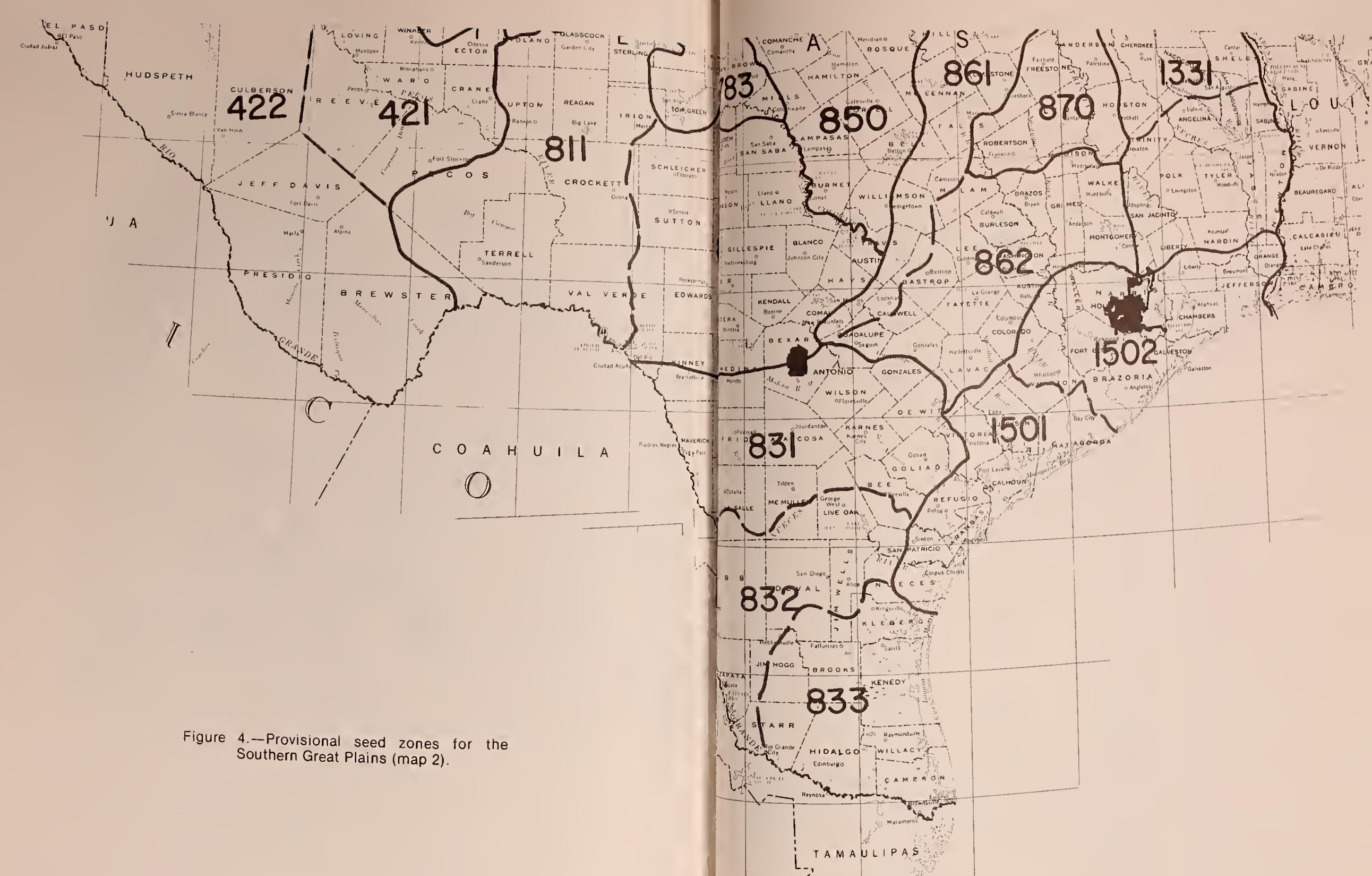


Figure 4.—Provisional seed zones for the Southern Great Plains (map 2).

Appendix

**TABLE 2.—Approximate equivalents of great soil groups of the modified 1938 Yearbook classification
in the classes in Soil Taxonomy (from Austin 1972, p. 81-82)**

1938 classification ¹	Soil Taxonomy ²	
Great soil groups	Most nearly corresponding taxa	Less common corresponding taxa
Alluvial soils.....	Fluvaquents Fluvents Fluventic subgroups of Inceptisols.	
Alpine Meadow soils.....	Cryaquods	Cryaquolls. Cryumbrepts.
Ando soils.....	Dystrandepts	Other great groups of Andepts.
Bog soils.....	Histosols	Histic subgroups of Aqualfs, Aquepts, and Aquolls.
Brown soils.....	Borolls (aridic subgroups) Ustolls (aridic subgroups) Xerolls (aridic subgroups) Aridisols (mollie subgroups)	Aridic Haploborolls. Durixerolls.
Brown Forest soils.....	Eutrochrepts	Haploixerolls. Hapludolls.
Brown Podzolic soils.....	Entic Haplorthods Entic Fragiorhods Cryandepts	Dystrochrepts. Fragiochrepts.
Brunizensis (Prairie soils).....	Udolls Argixerolls (typic subgroups) Haploixerolls (typic subgroups)	Udic Argiustolls.
Calcisols.....	Mollisols (calcic great groups) Aridisols (calcic great groups)	Ustocrepts. Xerocrepts.
Chernozem soils.....	Borolls (udic subgroups) Ustolls (udic subgroups)	Haploixerolls. Mollie Eutroboralfs. Boralfic Argiborolls.
Chestnut soils.....	Borolls (typic subgroups) Ustolls (typic subgroups)	Xerolls.
Desert soils.....	Aridisols (mesic and frigid families).	
Gray-Brown Podzolic soils.....	Udalfs	Aeric Ochraquals. Hapludults.
Gray Wooded soils.....	Boralfs	
Ground-Water Podzols.....	Aquods	Haplohumods.
Grumusols.....	Vertisols	Haplaquepts (vertic subgroups). Haplauolls (vertic subgroups). Rendolls.
Humic Gley soils.....	Umbragualls Aquolls Humaquepts	Andaquepts. Haplaquepts (mollie subgroups). Ochromaquals (mollie subgroups). Paleaquepts (umbric subgroups).
Litbosols.....	Orthents (lithic subgroups) Psammments (lithic subgroups)	Lithic subgroups of Alfisols, Aridisols, Inceptisols, Mollisols, and Ultisols.
Low-Humic Gley soils.....	Aquents Aquepts Aquults	Aqualfs. Paleaqueults. Psammaquents.
Noncalcic Brown soils.....	Xeralfs	Xerochrepts.

See footnotes at end of table.

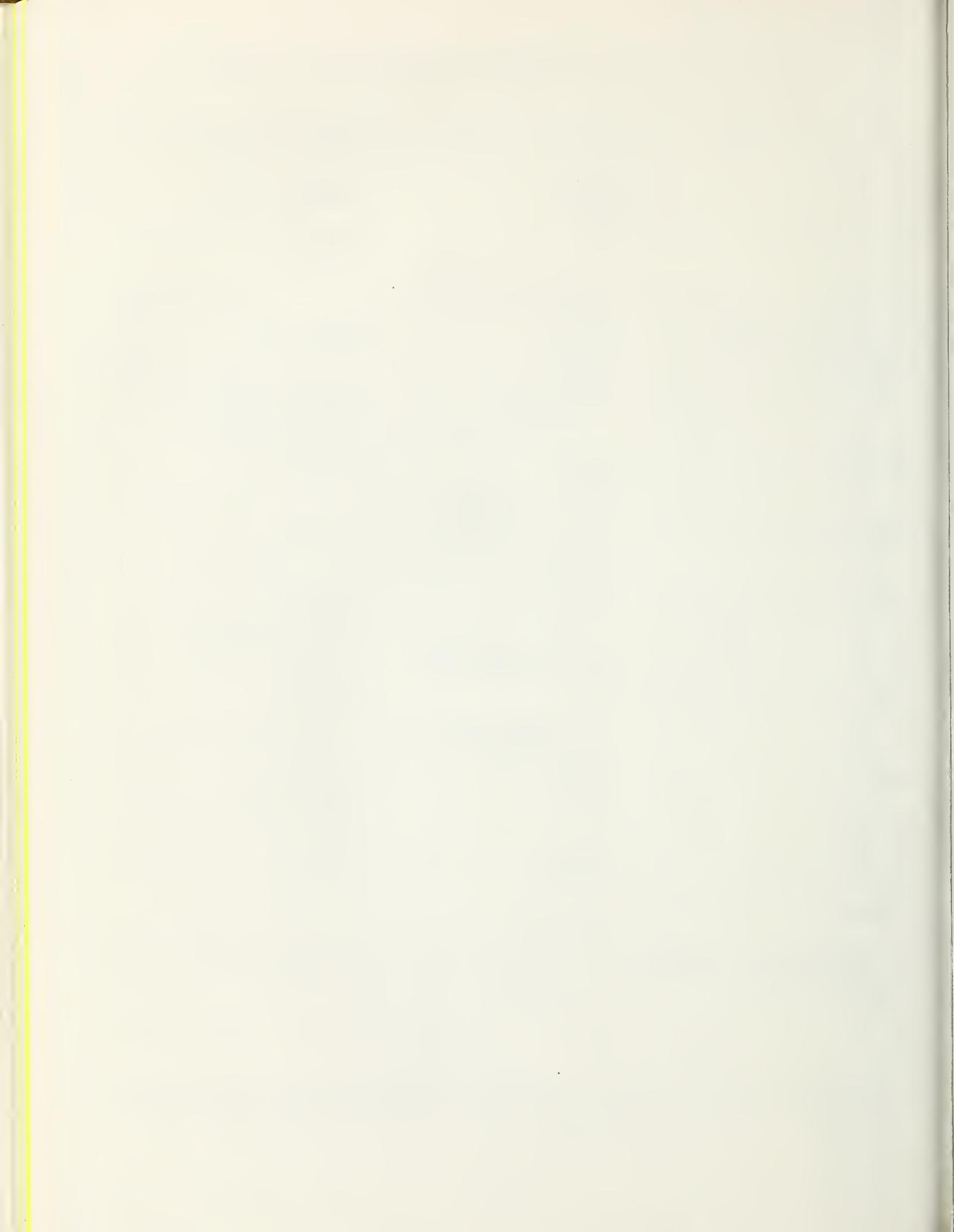
TABLE 2.—*Approximate equivalents of great soil groups of the modified 1938 Yearbook classification in the classes in Soil Taxonomy*—Continued

1938 classification ¹	Soil Taxonomy ²	
Great soil groups	Most nearly corresponding taxa	Less common corresponding taxa
Planosols.....	Alhaquults Alhaquals Albolls	Fragiaquults. Paleaquults.
Podzols.....	Orthods	Haplohumods. Dystrochrepts. Fragiochrepts.
Red Desert soils.....	Aridisols (thermic and hyperthermic families).	
Reddish-Brown Lateritic soils.....	Humults Rhodudults	Rhodic Paleudalfs. Rhodic Paleudults.
Reddish-Brown soils.....	Haplustalfs Paleustalfs Ustollic Haplargids	Aridic Argiustolls (thermic and hyperthermic families). Aridic Calciustolls (thermic and hyperthermic families). Aridic Haplustolls (thermic and hyperthermic families).
Reddish Chestnut soils.....	Haplustalfs Paleustalfs Typic and Aridic Argiustolls (thermic and hyperthermic families).	(warm) Haplustolls.
Reddish Prairie soils.....	Ustolls (udic subgroups, thermic and hyperthermic families). Paleudolls (thermic and hyperthermic families).	Eutrandepts.
Red-Yellow Podzolic soils.....	Udults	Paleudalfs. Haplustalfs (ultic subgroups). Paleustalfs (ultic subgroups).
Regosols.....	Great groups of Psammments Orthents (not lithic)	Grossarenic Paleudults. Xerochrepts.
Rendzina soils.....	Rendolls	Hapludolls. Eutrochrepts.
Sierozems.....	Aridisols (mollic great groups, mesic and frigid families).	Aridic subgroups of Mollisols.
Solonchak soils.....	Salorthids Calciqaquolls	Halaquepts. Aquic Calciustolls.
Solonetz soils.....	Natric great groups	Natric subgroups.
Sols Bruns Acides.....	Dystrochrepts Fragiochrepts Haplumbrepts Cryochrepts	Udorthent. Xerumhrept.
Subarctic Brown Forest soils.....	Umhrrihumults Haplumhrepts	Cryohorolls.
Yellowish-Brown Lateritic soils.....		

¹ Concepts of great soil groups are those given in the 1938 Yearbook of Agriculture pp. 996–1001 as modified in Soil Sci. 67: 117–126, 1949, and as modified in other publications and correlations prior to 1960.

² Soil Survey Staff, Soil Taxonomy. In preparation.*

*In October 1973, the Soil Survey Staff prepared an interim publication for inservice use, "Preliminary abridged text—Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys," 330 p., USDA Soil Conserv. Serv., Wash., D.C.



Cunningham, Richard A.
1975. Provisional tree and shrub seed zones for the Great
Plains. USDA For. Serv. Res. Pap. RM-150, 15 p. Rocky
Mt. For. and Range Exp. Stn., Fort Collins, Colo. 80521

The Great Plains Region was subdivided into 86 seed collection zones on the basis of soil, topography, water, and climate. Seed should be collected from the zone to be planted, or, if unavailable, from a zone having similar soil and climate. Future provenance test results will be used to determine any need for adjustments in zone boundaries.

Keywords: Seed zones, Great Plains, forest seed planting.

Cunningham, Richard A.
1975. Provisional tree and shrub seed zones for the Great
Plains. USDA For. Serv. Res. Pap. RM-150, 15 p. Rocky
Mt. For. and Range Exp. Stn., Fort Collins, Colo. 80521

The Great Plains Region was subdivided into 86 seed collection zones on the basis of soil, topography, water, and climate. Seed should be collected from the zone to be planted, or, if unavailable, from a zone having similar soil and climate. Future provenance test results will be used to determine any need for adjustments in zone boundaries.

Keywords: Seed zones, Great Plains, forest seed planting.

Cunningham, Richard A.
1975. Provisional tree and shrub seed zones for the Great
Plains. USDA For. Serv. Res. Pap. RM-150, 15 p. Rocky
Mt. For. and Range Exp. Stn., Fort Collins, Colo. 80521

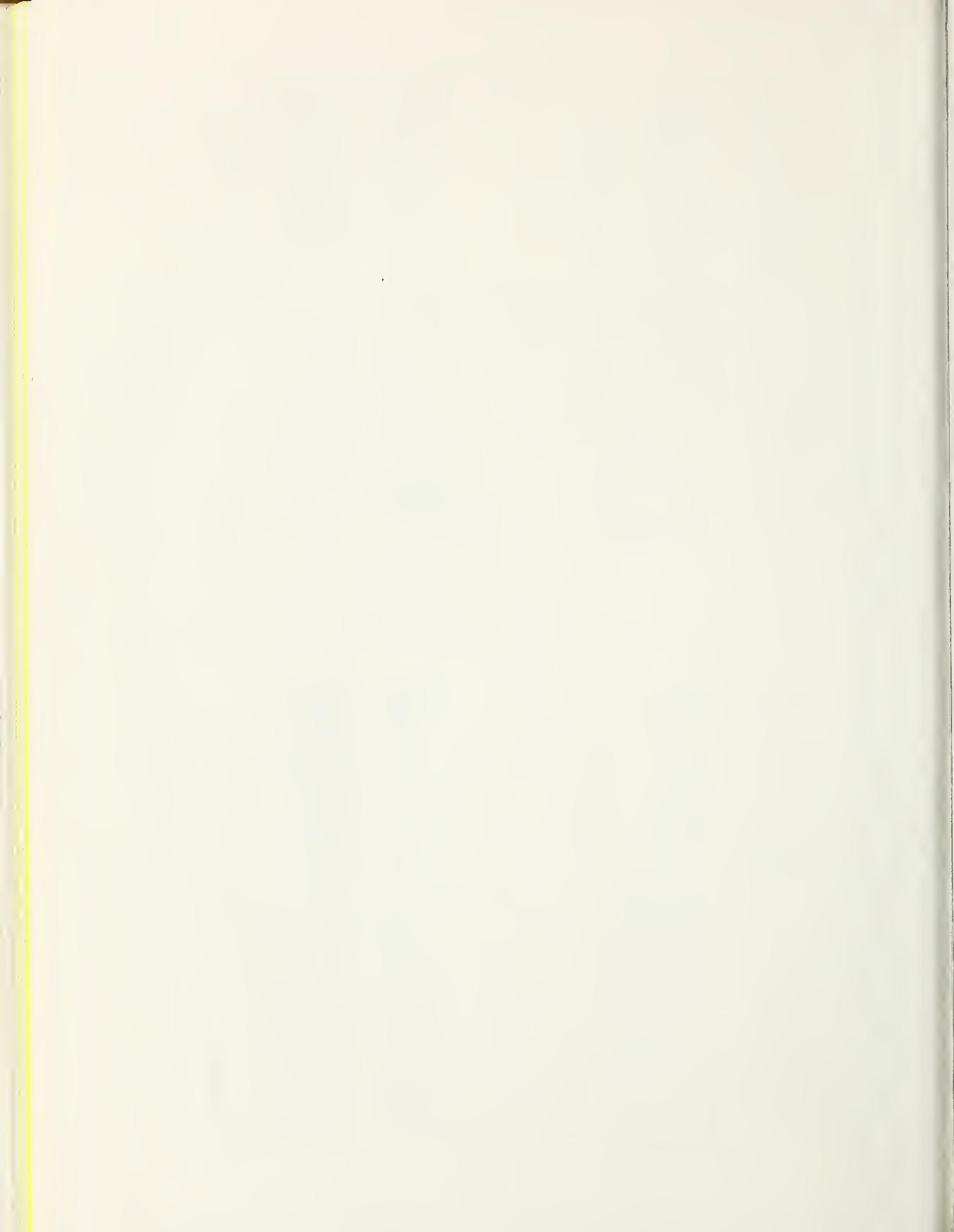
The Great Plains Region was subdivided into 86 seed collection zones on the basis of soil, topography, water, and climate. Seed should be collected from the zone to be planted, or, if unavailable, from a zone having similar soil and climate. Future provenance test results will be used to determine any need for adjustments in zone boundaries.

Keywords: Seed zones, Great Plains, forest seed planting.

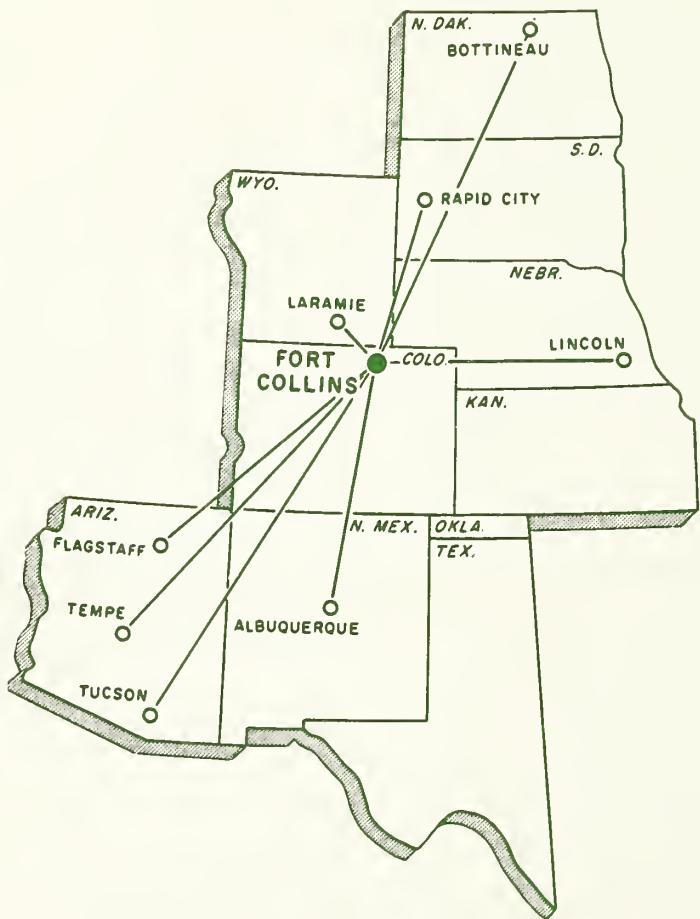
Cunningham, Richard A.
1975. Provisional tree and shrub seed zones for the Great
Plains. USDA For. Serv. Res. Pap. RM-150, 15 p. Rocky
Mt. For. and Range Exp. Stn., Fort Collins, Colo. 80521

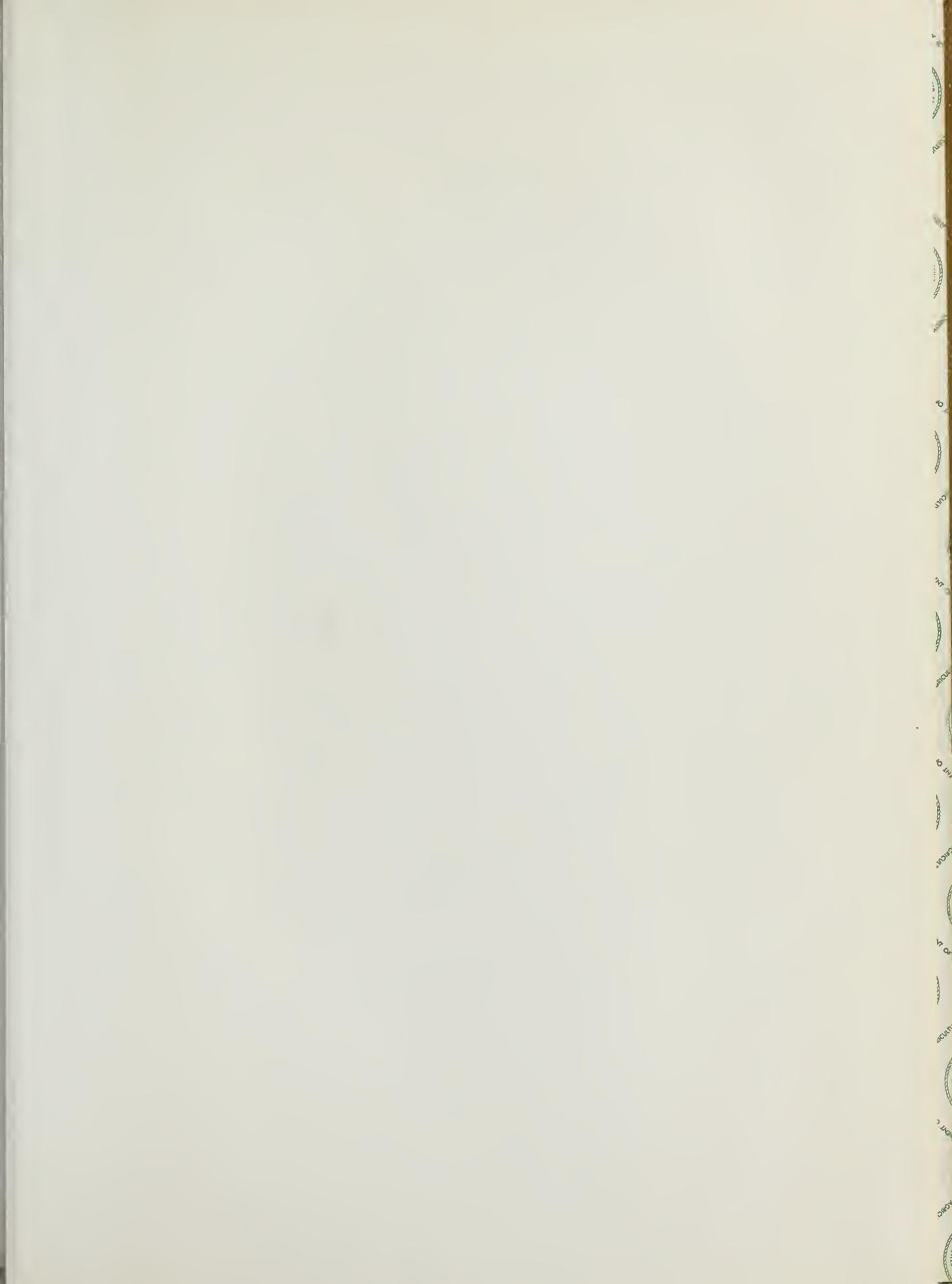
The Great Plains Region was subdivided into 86 seed collection zones on the basis of soil, topography, water, and climate. Seed should be collected from the zone to be planted, or, if unavailable, from a zone having similar soil and climate. Future provenance test results will be used to determine any need for adjustments in zone boundaries.

Keywords: Seed zones, Great Plains, forest seed planting.











1000
999
998
997
996
995
994
993
992
991
990
989
988
987
986
985
984
983
982
981
980
979
978
977
976
975
974
973
972
971
970
969
968
967
966
965
964
963
962
961
960
959
958
957
956
955
954
953
952
951
950
949
948
947
946
945
944
943
942
941
940
939
938
937
936
935
934
933
932
931
930
929
928
927
926
925
924
923
922
921
920
919
918
917
916
915
914
913
912
911
910
909
908
907
906
905
904
903
902
901
900
899
898
897
896
895
894
893
892
891
890
889
888
887
886
885
884
883
882
881
880
879
878
877
876
875
874
873
872
871
870
869
868
867
866
865
864
863
862
861
860
859
858
857
856
855
854
853
852
851
850
849
848
847
846
845
844
843
842
841
840
839
838
837
836
835
834
833
832
831
830
829
828
827
826
825
824
823
822
821
820
819
818
817
816
815
814
813
812
811
810
809
808
807
806
805
804
803
802
801
800
799
798
797
796
795
794
793
792
791
790
789
788
787
786
785
784
783
782
781
780
779
778
777
776
775
774
773
772
771
770
769
768
767
766
765
764
763
762
761
760
759
758
757
756
755
754
753
752
751
750
749
748
747
746
745
744
743
742
741
740
739
738
737
736
735
734
733
732
731
730
729
728
727
726
725
724
723
722
721
720
719
718
717
716
715
714
713
712
711
710
709
708
707
706
705
704
703
702
701
700
699
698
697
696
695
694
693
692
691
690
689
688
687
686
685
684
683
682
681
680
679
678
677
676
675
674
673
672
671
670
669
668
667
666
665
664
663
662
661
660
659
658
657
656
655
654
653
652
651
650
649
648
647
646
645
644
643
642
641
640
639
638
637
636
635
634
633
632
631
630
629
628
627
626
625
624
623
622
621
620
619
618
617
616
615
614
613
612
611
610
609
608
607
606
605
604
603
602
601
600
599
598
597
596
595
594
593
592
591
590
589
588
587
586
585
584
583
582
581
580
579
578
577
576
575
574
573
572
571
570
569
568
567
566
565
564
563
562
561
560
559
558
557
556
555
554
553
552
551
550
549
548
547
546
545
544
543
542
541
540
539
538
537
536
535
534
533
532
531
530
529
528
527
526
525
524
523
522
521
520
519
518
517
516
515
514
513
512
511
510
509
508
507
506
505
504
503
502
501
500
499
498
497
496
495
494
493
492
491
490
489
488
487
486
485
484
483
482
481
480
479
478
477
476
475
474
473
472
471
470
469
468
467
466
465
464
463
462
461
460
459
458
457
456
455
454
453
452
451
450
449
448
447
446
445
444
443
442
441
440
439
438
437
436
435
434
433
432
431
430
429
428
427
426
425
424
423
422
421
420
419
418
417
416
415
414
413
412
411
410
409
408
407
406
405
404
403
402
401
400
399
398
397
396
395
394
393
392
391
390
389
388
387
386
385
384
383
382
381
380
379
378
377
376
375
374
373
372
371
370
369
368
367
366
365
364
363
362
361
360
359
358
357
356
355
354
353
352
351
350
349
348
347
346
345
344
343
342
341
340
339
338
337
336
335
334
333
332
331
330
329
328
327
326
325
324
323
322
321
320
319
318
317
316
315
314
313
312
311
310
309
308
307
306
305
304
303
302
301
300
299
298
297
296
295
294
293
292
291
290
289
288
287
286
285
284
283
282
281
280
279
278
277
276
275
274
273
272
271
270
269
268
267
266
265
264
263
262
261
260
259
258
257
256
255
254
253
252
251
250
249
248
247
246
245
244
243
242
241
240
239
238
237
236
235
234
233
232
231
230
229
228
227
226
225
224
223
222
221
220
219
218
217
216
215
214
213
212
211
210
209
208
207
206
205
204
203
202
201
200
199
198
197
196
195
194
193
192
191
190
189
188
187
186
185
184
183
182
181
180
179
178
177
176
175
174
173
172
171
170
169
168
167
166
165
164
163
162
161
160
159
158
157
156
155
154
153
152
151
150
149
148
147
146
145
144
143
142
141
140
139
138
137
136
135
134
133
132
131
130
129
128
127
126
125
124
123
122
121
120
119
118
117
116
115
114
113
112
111
110
109
108
107
106
105
104
103
102
101
100
99
98
97
96
95
94
93
92
91
90
89
88
87
86
85
84
83
82
81
80
79
78
77
76
75
74
73
72
71
70
69
68
67
66
65
64
63
62
61
60
59
58
57
56
55
54
53
52
51
50
49
48
47
46
45
44
43
42
41
40
39
38
37
36
35
34
33
32
31
30
29
28
27
26
25
24
23
22
21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0

